# PATENT ABSTRACTS OF JAPAN

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(71)Applicant : NICHIA CHEM IND LTD
(72)Inventor : OCHIAI MASANAO

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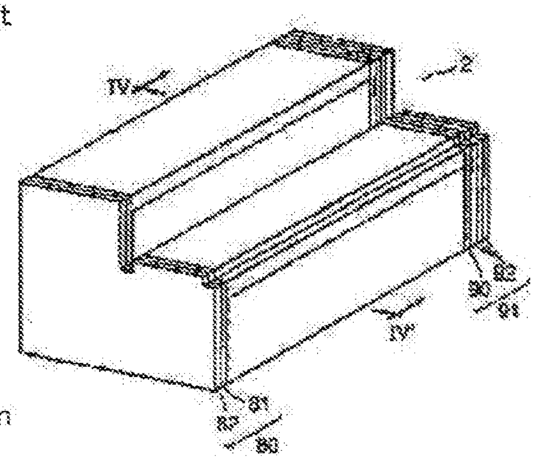
## (54) GALLIUM NITRIDE LIGHT-EMITTING ELEMENT

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a gallium nitride light-emitting element in high slope efficiency and high-reliability with its life prolonged by suppressing a braking of the end surface of the light-emitting element during the high-output operation of the light-emitting element.
SOLUTION: A gallium nitride light-emitting element is formed in a structure that more than one layer of low reflective films having refractive indexes lower than that of a gallium nitride are laminated on a light emitting side mirror surface, in such a way that the refractive indexes become lower in order from the light emitting side mirror surface, and the first low reflective film directly over the mirror surface is formed of one kind of a material of either selected from among a ZrO2, an MgO, an Al2O3, an Si3N4, an AlN and an MgF2. Moreover, a protective film consisting of one kind of a material of either selected from among a ZrO2, an MgO, an Si3N4, an AlN and an MgF2 is formed on the mirror surface and a high reflective film formed by alternately laminating low-refractive index-layers and high-refractive index layers is formed on the protective film.






## CLAIMS

[Claim(s)]
[Claim 1]In a gallium nitride system light emitting device which has the resonator structure which has an optical outgoing radiation side-mirrors side and a light reflex side-mirrors side in a both-ends side of a luminous layer of stripe shape, A low reflective film more than two-layer [ which has a refractive index lower than gallium nitride in an optical outgoing radiation side-mirrors side ], From this optical outgoing radiation side-mirrors side, laminate so that a refractive index may become low in order, and the 1st low reflective film right above this optical

outgoing radiation side-mirrors side, A gap to be chosen from $ZrO_2$, MgO, aluminum$_2O_3$, $Si_3N_4$, AlN, and $MgF_2$, or a gallium nitride system light emitting device which consists of one sort.

[Claim 2]The 1st low reflective film of the above comprises a gap to be chosen from $ZrO_2$, $Si_3N_4$, and AlN, or one sort, The gallium nitride system light emitting device according to claim 1 which comes to form a gap to be chosen from $SiO_2$, aluminum$_2O_3$, MgO, and $MgF_2$, or the 2nd low reflective film that consists of one sort on the 1st low reflective film.

[Claim 3]A gap which wants to form [ gap ] in the above-mentioned optical outgoing radiation side-mirrors side a low reflective film of one layer which has a refractive index lower than gallium nitride, and to choose this low reflective film from MgO, aluminum$_2O_3$, and $MgF_2$, or the gallium nitride system light emitting device according to claim 1 which consists of one sort.

[Claim 4]A gap to be chosen from $ZrO_2$, MgO, $Si_3N_4$, AlN, and $MgF_2$ or a protective film which consists of one sort is formed in the above-mentioned light reflex side-mirrors side, And a gallium nitride system light emitting device of any one statement of claim 1-3 which forms a high reflection film which laminates a low refractive index layer and a high refractive index layer by turns on this protective film.

[Claim 5]In a gallium nitride system light emitting device which has the resonator structure which has an optical outgoing radiation side-mirrors side and a light reflex side-mirrors side in a both-ends side of a luminous layer of stripe shape, A gap to be chosen from $ZrO_2$, MgO, $Si_3N_4$, AlN, and $MgF_2$ or a protective film which consists of one sort is formed in a light reflex side-mirrors side, And a gallium nitride system light emitting device which forms a high reflection film which laminates a low refractive index layer and a high refractive index layer by turns on this protective film.

[Claim 6]In a gallium nitride system light emitting device which it has, resonator structure which has an optical outgoing radiation side-mirrors side and a light reflex side-mirrors side in a both-ends side of a luminous layer of stripe shape in an optical outgoing radiation side-mirrors side. From this optical outgoing radiation side-mirrors side, a low reflective film more than two-layer [ which has a refractive index lower than gallium nitride ] is laminated so that a refractive index may become low in order, The 1st low reflective film right above this optical outgoing radiation side-mirrors side comprises a gap to be chosen from $ZrO_2$, MgO, aluminum$_2O_3$, $Si_3N_4$, AlN, and $MgF_2$, or one sort, A gap to be chosen from $ZrO_2$, MgO, $Si_3N_4$, AlN, and $MgF_2$ or a protective film which consists of one sort is formed in a light reflex side-mirrors side, And a gallium nitride system light emitting device gallium nitride system light emitting device which comes to form a high reflection film which laminates a low refractive index layer and a high refractive index layer by turns on this protective film.

[Claim 7]The gallium nitride system light emitting device according to claim 4 to 6 which the above-mentioned low refractive index layer and the above-mentioned high refractive index layer become from $SiO_2$ and $ZrO_2$, respectively.

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[Translation done.]



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## DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[Field of the Invention]This invention relates to the gallium nitride system light emitting device which is used for a light emitting diode or a laser diode and which was excellent in reliability by high power.

[0002]

[Description of the Prior Art]Drawing 5 is a typical perspective view showing the structure of the conventional

nitride semiconductor light emitting element. This light emitting device 100, On the silicon on sapphire 101, the buffer layer 102, the n type contact layer 103, the crack prevention layer 104, the n type clad layer 105, the n type guide layer 106, the active layer 107, the p type capping layer 108, the p type guide layer 109, the p type clad layer 110, The p type contact layer 111 is laminated one by one, the luminous layer of stripe shape is formed of dry etching, it ranks second and the p lateral electrode 112 and the n lateral electrode 113 are formed. The high reflection film 120 which carried out the plural laminates of the cascade screen 121 of $SiO_2$ and $TiO_2$ is formed in the mirror plane by the side of [ after forming a cleavage plane ] a light reflex by predetermined cavity length, and it enables it to take out oscillation light efficiently from the mirror plane by the side of optical outgoing radiation.

[0003]

[Problem(s) to be Solved by the Invention]However, when it was made to operate more than by high power, for example, 30 mW, in the mirror plane by the side of a light reflex, end face destruction breaks out easily, and there was a problem that a life fell. When making it operate by high power and slope efficiency was low, there was also a problem that driving current will become large.

[0004]Then, an object of this invention was to control the end face destruction at the time of high output operation, to raise a life and to provide a highly reliable nitride semiconductor light emitting element with high slope efficiency.

[0005]

[Means for Solving the Problem]In a gallium nitride light emitting device which has the resonator structure to which this invention has an optical outgoing radiation side-mirrors side and a light reflex side-mirrors side in a both-ends side of a luminous layer of stripe shape in order to solve an aforementioned problem, A low reflective film more than two-layer [ which has a refractive index lower than gallium nitride in an optical outgoing radiation side-mirrors side ], From this optical outgoing radiation side-mirrors side, it laminates so that a refractive index may become low in order, and the 1st low reflective film right above this optical outgoing radiation side-mirrors side consists of a gap to be chosen from $ZrO_2$, MgO, aluminum$_2$O$_3$, $Si_3N_4$, AlN, and $MgF_2$, or one sort.

[0006]Since a low reflective film more than two-layer [ which has a refractive index lower than gallium nitride in an optical outgoing radiation side-mirrors side ] is laminated from this optical outgoing radiation side-mirrors side so that a refractive index may become low in order, a gallium nitride system light emitting device of this invention, Reflection of oscillation light is controlled and a rate of oscillation light taken out from an optical outgoing radiation side-mirrors side can be made to increase compared with a case where oscillation light is directly taken out from an optical outgoing radiation side-mirrors side in the air. By using for the 1st low reflective film right above an optical outgoing radiation side-mirrors side a gap to be chosen from $ZrO_2$, MgO, aluminum$_2$O$_3$, $Si_3N_4$, AlN, and $MgF_2$, or a thing which consists of one sort, Since degradation of an optical outgoing radiation side-mirrors side by a reaction of gallium nitride and a low reflective film at the time of operation can be controlled, a life of a light emitting device is raised.

[0007]A gallium nitride system light emitting device of this invention comprises a gap which wants to choose the 1st low reflective film from $ZrO_2$, $Si_3N_4$, and AlN, or one sort, A thing which comes to form a gap to be chosen from $SiO_2$, aluminum$_2$O$_3$, MgO, and $MgF_2$ or the 2nd low reflective film that consists of one sort on the 1st low reflective film can be used.

[0008]A low reflective film of one layer in which a gallium nitride system light emitting device of this invention has a refractive index lower than gallium nitride in an optical outgoing radiation side-mirrors side is formed, and this low reflective film can use a gap to be chosen from MgO, aluminum$_2$O$_3$, and $MgF_2$, or a thing which consists of one sort.

[0009]A gallium nitride system light emitting device of this invention forms in a light reflex side-mirrors side a gap to be chosen from $ZrO_2$, MgO, $Si_3N_4$, AlN, and $MgF_2$, or a protective film which consists of one sort, And what forms a high reflection film which laminates a low refractive index layer and a high refractive index layer by turns on this protective film can be used.

[0010]In a gallium nitride system light emitting device which has the resonator structure to which a gallium nitride system light emitting device of this invention has an optical outgoing radiation side-mirrors side and a light reflex side-mirrors side in a both-ends side of a luminous layer of stripe shape, A low reflective film more than two-layer [ which has a refractive index lower than gallium nitride in an optical outgoing radiation side-mirrors side ], From this optical outgoing radiation side-mirrors side, laminate so that a refractive index may become low in order, and the 1st low reflective film right above this optical outgoing radiation side-mirrors side, Comprise a gap to be chosen from $ZrO_2$, MgO, aluminum$_2$O$_3$, $Si_3N_4$, AlN, and $MgF_2$, or one sort, and in a light

reflex side-mirrors side. A gap to be chosen from $ZrO_2$, MgO, $Si_3N_4$, AlN, and $MgF_2$ or a protective film which consists of one sort is formed, and it comes to form a high reflection film which laminates a low refractive index layer and a high refractive index layer by turns on this protective film.

[0011]In a gallium nitride system light emitting device of this invention, what consists of $SiO_2$ and $ZrO_2$ can be used for the above-mentioned low refractive index layer and the above-mentioned high refractive index layer, respectively.

[0012]

[Embodiment of the Invention]Hereafter, although this invention is explained using a drawing, the gallium nitride system light emitting device of this invention is not limited to the element structure or the electrode configuration which were shown in the embodiment.

[0013]The embodiment 1. book embodiment 1 is related with the gallium nitride system light emitting device which used the nitride semiconductor substrate for the substrate. Drawing 1 and drawing 2 are the mimetic diagrams showing the structure of the gallium nitride system light emitting device concerning the embodiment of the invention 1, and are a sectional view showing section structure [ in / drawing 1 can be set in a perspective view and / in drawing 2 / the II-II' line of drawing 1 ]. As shown in drawing 1, this light emitting device 1 is provided with the following.

About the multilayer low reflective film 80 which becomes an optical outgoing radiation side-mirrors side from the 1st low reflective film 81 and 2nd low reflective film 82, it is the protective film 90 in a light reflex side-mirrors side.

The high reflection film 91 in which the plural laminates of the cascade screen 92 of a low refractive index layer and a high refractive index layer were carried out.

[0014]As shown in drawing 2, this light emitting device 1 has the nitride semiconductor substrate 11 which consists of GaN(s), and the n type contact layer 12 which consists of n type GaN is formed on the substrate 11. On this n type contact layer 12, the crack prevention layer 13 which consists of n type InGaN is formed, and the n type guide layer 15 which consists of the n type clad layer 14 which consists of n type AlGaN/GaN, and n type GaN is formed on this crack prevention layer 13. On the n type guide layer 15, the active layer 16 which consists of InGaN/InGaN of multiple quantum well structure is formed, and the p type capping layer 17 which consists of p type AlGaN is formed on the active layer 16. On the p type capping layer 17, the p type guide layer 18 which consists of p type GaN is formed, and the p type clad layer 19 which consists of p type AlGaN/GaN, and the p type contact layer 20 which consists of p type GaN are formed on it. And the p lateral electrode 23 is formed on the p type contact layer 20, and the n lateral electrode 22 is formed on the n type contact layer 12.

[0015]In this Embodiment 1, since the rearrangement of a nitride semiconductor grown up on it by using the substrate which consists of nitride semiconductors can be controlled and crystallinity can be improved, the life of a light emitting device can be raised more.

[0016]A growing method of the good crystalline nitride semiconductor with which the substrate which consists of nitride semiconductors was indicated to JP,11-191659,A here, for example. (it is hereafter called an ELOG (Epitaxially laterally overgrown GaN) grown method.) -- it can use and produce. That is, C side is made into the principal surface and the buffer layer which comes from GaN on the silicon on sapphire which makes an orientation flat (cage hula) side A side is grown up. The 1st nitride semiconductor layer that consists of undoped GaN is grown up after buffer layer growth. Next, form the photo mask of stripe shape and the $SiO_2$ film patterned by the sputter device is formed, Then, the 1st nitride semiconductor is exposed on the crevice side by etching until silicon on sapphire exposes the 1st nitride semiconductor of the portion in which a $SiO_2$ film is not formed by an RIE system, and forming unevenness. Next, $SiO_2$ of the upper part of heights is removed. Next, the 2nd nitride semiconductor layer that consists of GaN which doped Si is grown up. Next, the wafer into which the 2nd nitride semiconductor layer was grown up is picked out from a reaction vessel, silicon on sapphire, a buffer layer, the 1st nitride semiconductor layer, and a $SiO_2$ film are ground and removed, and the substrate which consists only of the 2nd nitride semiconductor layer is obtained.

[0017]It has a refractive index lower than GaN (refractive index 2.3), and the melting point is the material which was highly excellent in thermal stability, and the material which does not have absorption in the oscillation wavelength region of a light emitting device still more preferably can be used for the low reflective film formed in a light emitting surface side-mirrors side. As a material which fulfills these conditions, for example $ZrO_2$ (refractive index 2.1), MgO (refractive index 1.7), aluminum$_2O_3$ (refractive index 1.54), $Si_3N_4$ (refractive index 2.0), AlN (refractive index 2.0), and $MgF_2$ (refractive index 1.4) can be mentioned.

[0018]Here, as for the low reflective film formed in a light emitting surface side-mirrors side, it is preferred to consider it as the multilayer more than two-layer. This low reflective film can suppress reflection of the light in a light emitting surface side-mirrors side, and turns into an antireflection film.
[0019]As for this low reflective film, it is desirable to laminate a low reflective film from a light emitting surface side-mirrors side, so that a refractive index may become low in order. Although $ZrO_2$, $Si_3N_4$, and any one sort of materials of AlN can be used for the 1st low reflective film right above a light emitting surface side-mirrors side, its $ZrO_2$ excellent in thermal stability is desirable. Any one sort of materials of $SiO_2$, aluminum$_2O_3$, MgO, and $MgF_2$ can be used for the 2nd low reflective layer. As for a low reflective film, when it may form by one layer and makes it into one layer, it is desirable to use any one material of MgO, aluminum$_2O_3$, and the $MgF_2$.
[0020]A low reflective film can be formed using gaseous phase membrane formation art, such as vacuum evaporation, weld slag, and CVD. As for the thickness of a low reflective film, it is desirable to set an oscillation wavelength to lambda/4n, if the refractive index of lambda and a low reflective film is set to n. When a low reflective film is carried out to more than two-layer, the thickness of the 1st low reflective film is good also as lambda/2n.
[0021]The material the melting point excelled [ material ] in thermal stability highly can be used for the protective film formed in a light reflex side-mirrors side. For example, it is desirable to use $ZrO_2$, although $ZrO_2$, MgO, $Si_3N_4$, AlN, and $MgF_2$ can be mentioned. By providing this film, degradation of the end face which had happened between GaN and $SiO_2$ with the conventional structure can be prevented.
[0022]A protective film can be formed using gaseous phase membrane formation art, such as vacuum evaporation, weld slag, and CVD. It is desirable for the thickness of a protective film to set an oscillation wavelength to lambda/4n, or lambda/2n, if the refractive index of lambda and a protective film is set to n.
[0023]On a protective film, the high reflection film which laminated the low refractive index layer and the high refractive index layer by turns is formed. Can use for this high reflection film the material currently used for the conventional laser diode etc., for example, as combination of a (low refractive index layer:high refractive index layer), ($SiO_2$:$ZrO_2$) -- or ($SiO_2$:$TiO_2$) -- etc. -- although using is most preferred, it is also good to choose the combination of material with a low refractive index, and a high material relatively as this combination.
[0024]As for a low refractive index layer and a high refractive index layer, when a protective film is provided, it is preferred to consider it as the high reflection film of two to five pairs which repeated these by turns and laminated them. It is considered as three pairs or four pairs still more preferably, and is most preferably considered as three pairs. By doing in this way, the life of a light emitting device can be further raised by high power.
[0025]It is [ optical outgoing radiation side ] preferred to form, where it pushed down cleavage on bar shape and a bar is toppled 90 degrees, after cutting towards becoming vertical to the stripe of each luminous layer about a wafer as a formation method of the low reflective film to a light reflex side-mirrors side and a high reflection film. This is a thing in consideration of the characteristic of vapor phase growth systems used for film formation, such as vacuum evaporation and weld slag, and can obtain the low reflective film of uniform thickness, and a high reflection film by installing and forming the film formation side used as a membranous growth direction so that the target of a deposition source and weld slag may be countered. By the effect of the surroundings lump in vapor phase epitaxy, even if it does not topple a bar 90 degrees, it can form, but compared with the film pushed down and formed, the homogeneity of thickness is inferior. It is as good as formation in a film using a surroundings lump without pushing down 90 degrees, when a bar is toppled 90 degrees when the resonator face which becomes the optical outgoing radiation and light reflex side is a field formed of cleavage, and a resonator face is a field formed by etching.
[0026]The embodiment 2. book embodiment 2 is related with the gallium nitride system light emitting device using the different-species board which has in a substrate the nitride semiconductor layer formed in the ELOG growth method. Drawing 3 and drawing 4 are the mimetic diagrams showing the structure of the gallium nitride system light emitting device concerning this Embodiment 2. It is a sectional view showing section structure [ in / drawing 3 can be set in a perspective view and / in drawing 4 / the IV-IV' line of drawing 3 ]. As shown in drawing 3, this light emitting device is provided with the following.
About the multilayer low reflective film 80 which becomes an optical outgoing radiation side-mirrors side from the 1st low reflective film 81 and 2nd low reflective film 82, it is the protective film 90 in a light reflex side-mirrors side.
The high reflection film 91 in which the plural laminates of the cascade screen 92 of a low refractive index layer and a high refractive index layer were carried out.

[0027]As shown in drawing 4, this light emitting device 1 has the silicon on sapphire 31, and the buffer layer 32 which consists of GaN(s) is formed on the substrate 31. On this buffer layer 32, undoped GaN layers 33 and 34 used as a foundation layer are formed. On undoped GaN layer 34, the n type contact layer 35 which consists of n type GaN is formed, and the crack prevention layer 36 which consists of n type InGaN is formed on it. On the crack prevention layer 36, the n type clad layer 37 which consists of n type GaN, the n type guide layer 38 which consists of undoped GaN on it, and the active layer 39 which consists of n type InGaN/InGaN of multiple quantum well structure on it are formed. It is formed on the active layer 39 by the p type capping layer 40 which consists of p type AlGaN, and on it, The p type guide layer 41 which consists of undoped GaN is formed, the p type clad layer 42 which consists of p type AlGaN/GaN is formed on it, and the p type contact layer 43 which consists of p type GaN is formed on the p type clad layer 42. The pad electrode 70 is further formed for the p lateral electrode 50 via the opening of the 2nd insulator layer 61 via the opening of the 1st insulator layer 60 on the p type contact layer 43.
[0028]The different-species board which has the nitride semiconductor layer formed in the ELOG growth method is producible using the method indicated to JP,11-191659,A, for example. That is, C side is made into the principal surface and the buffer layer which comes from GaN on the silicon on sapphire which makes an orientation flat (cage hula) side A side is grown up. The 1st nitride semiconductor layer that consists of undoped GaN is grown up after buffer layer growth. Next, form the photo mask of stripe shape and the $SiO_2$ film patterned by the sputter device is formed, Then, the 1st nitride semiconductor is exposed on the crevice side by etching until silicon on sapphire exposes the 1st nitride semiconductor of the portion in which a $SiO_2$ film is not formed by an RIE system, and forming unevenness. Next, $SiO_2$ of the upper part of heights is removed. Next, it is producible by growing up the 2nd nitride semiconductor layer that consists of GaN which doped Si.
[0029]As a substrate into which a nitride semiconductor is grown up, it is sapphire (the Cth page of the principal surface.). ZnO, a spinel ($MgAl_2O_4$), SiC, GaAs besides R side and A side, SiC (6H, 4H, and 3C are included), etc. can use the different-species board which is known conventionally and which consists of a different material from a nitride semiconductor, in order to grow up a nitride semiconductor.
[0030]According to this Embodiment 2, by the same method as Embodiment 1, a low reflective film can be formed in an optical outgoing radiation side-mirrors side, a protective film can be formed in the light reflection surface side, and the same effect as Embodiment 1 can be acquired.
[0031]Although the example using a nitride semiconductor substrate and different-species boards, such as sapphire which has the nitride semiconductor layer formed by the ELOG growth method, was shown in the substrate in Embodiments 1 and 2, respectively, When the different-species board which does not have the nitride semiconductor layer formed by the ELOG growth method is used, it cannot be overemphasized that the same effect as Embodiments 1 and 2 is acquired.
[0032]Although it is possible for the optical outgoing radiation side in Embodiment 2 to form also by the same method as Embodiment 1 as a formation method of the low reflective film to a light reflex side-mirrors side and a high reflection film, Since it is difficult to be hard to carry out cleavage of the different-species board, and to form in bar shape, it can also form as follows besides the method of Embodiment 1.
[0033]After growing up and low-resistance-izing a p type contact layer, the surface of a n type contact layer is exposed by etching, but the resonator face by the side of optical outgoing radiation and a light reflex is also formed by etching in that case. That is, an optical outgoing radiation side-mirrors side and a light reflex side-mirrors side are acquired by the etching. Next, a low reflective film and a high reflection film are formed in the optical outgoing radiation side-mirrors side and light reflex side-mirrors side which were acquired by etching with a vapor phase growth system using a surroundings lump.
[0034]It etches further and a slot is formed until sapphire exposes the surrounding nitride semiconductor layer of an element as a desirable formation method so that it may be easy to carry out chip making of the element for n molding surface by etching, after acquiring an optical outgoing radiation side-mirrors side and a light reflex side-mirrors side simultaneously, exposure. At this time, at least, further, an optical outgoing radiation side etches the light reflex side in a position which does not interrupt emitted light so that the laser beam to emit may serve as a good far field pattern. Next, a low reflective film and a high reflection film are formed in an optical outgoing radiation side-mirrors side and a light reflex side-mirrors side with a vapor phase growth system using a surroundings lump. Since the heterogeneity of the thickness of a low reflective film with the mask at the time of forming etching using a mask and a high reflection film is avoidable by forming in this way and chip making is easily made in the position which even sapphire etched, it is desirable.
[0035]
[Example]In Examples 2 and 3, the nitride semiconductor substrate was used for the substrate for the silicon on

sapphire which has the nitride semiconductor layer made [ the substrate ] to carry out ELOG growth to Example 1.
[0036]Example 1 is described using example 1. drawing 4. (0001) The substrate 31 which consists of silicon-on-sapphire sapphire which makes C side the principal surface was set in the MOVPE reaction vessel, temperature was 500 **, and the buffer layer 32 which consists of GaN(s) was grown up by 200-A thickness using trimethylgallium (TMG) and ammonia ($NH_3$).
[0037]Next, only TMG was stopped after buffer layer growth and temperature was raised to 1050 **. When becoming 1050 **, TMG and ammonia were used for material gas and undoped GaN layer 33 was grown up by 2-micrometer thickness. Form the photo mask of stripe shape and with a sputter device Then, the stripe width (portion which becomes the upper part of heights) of 5 micrometers, The $SiO_2$ film patterned after 10 micrometers of stripe intervals (portion used as the pars basilaris ossis occipitalis of a crevice) is formed. Then, after exposing undoped GaN layer 33 on the crevice side by etching until the substrate 31 exposes undoped GaN layer 33 of a portion in which a $SiO_2$ film is not formed by an RIE system, and forming unevenness, $SiO_2$ of the heights upper part was removed. Next, it set in the reaction vessel, TMG and ammonia were used for material gas by ordinary pressure, and undoped GaN layer 34 was grown up by 2-micrometer thickness. In growth of each class which forms element structure, the foundation layer which consists of undoped GaN layer 33 and undoped GaN layer 34 acts as a substrate.
[0038]Next, at the temperature of 1050 **, TMG and ammonia were used for the raw material at gas, silane gas ($SiH_4$) was used for impurity gas, and the n type contact layer 35 which consists of GaN which $cm^{-3}$[ $3x10^{18}$/]-doped Si was grown up by 4-micrometer thickness.
[0039]Next, temperature shall be 800 ** and TMG, TMI (trimethylindium), and ammonia are used for material gas, Silane gas was used for impurity gas and the crack prevention layer 36 which consists of $In_{0.06}Ga_{0.94}N$ which $cm^{-3}$[ $5x10^{18}$/]-doped Si was grown up by 0.15 micrometer of thickness.
[0040]Temperature shall be 1050 ** and to material gas Next, TMA (trimethylaluminum), Using TMG and ammonia, undoped $aluminum_{0.14}Ga_{0.86}N$ was grown up by 25-A thickness, then TMA was stopped, and GaN which $cm^{-3}$[ $1x10^{19}$/]-doped Si was grown up by 25-A thickness, using silane gas as impurity gas. This operation was repeated by turns and the n type clad layer 37 which consists of a superstructure of 1.2 micrometers of the total thickness was grown up.
[0041]Next, TMG and ammonia were used for material gas at the temperature of 1050 **, and the n type guide layer 38 which consists of undoped GaN was grown up by 0.2 micrometer of thickness.
[0042]Next, temperature was 800 **, TMG, TMI, and ammonia were used for material gas, silane gas was used for impurity gas, and the barrier layer (B horizon) which consists of $In_{0.05}Ga_{0.95}N$ which $cm^{-3}$[ $5x10^{18}$/]-doped Si was grown up by 100-A thickness. Then, silane gas is stopped and the well layer (W layer) which consists of undoped $In_{0.2}Ga_{0.8}N$ is grown up by 40-A thickness. The barrier layer and the well layer were laminated in order of the B horizon-W layer-B horizon-W layer-B horizon, and the active layer 39 of the multiple quantum well structure of 380 A of the total thickness was grown up.
[0043]Next, TMA, TMG, and ammonia are used for material gas at the temperature of 800 **, The p type capping layer 40 which consists of $aluminum_{0.3}Ga_{0.7}N$ which $cm^{-3}$[ $1x10^{20}$/]-doped Mg was grown up by 300-A thickness, using $Cp_2Mg$ (magnesium cyclopentadienyl) as impurity gas.
[0044]Next, temperature was 1050 **, TMG and ammonia were used for material gas, and the p type guide layer 41 which consists of undoped GaN was grown up by 0.1 micrometer of thickness. Although this p type guide layer was grown up as undoped, by diffusion of Mg from the p type capping layer 40, Mg concentration serves as $1x10^{18}/cm^3$, and it shows a p type.
[0045]Next, TMA, TMG, and ammonia are used for material gas at the temperature of 1050 **, Undoped $aluminum_{0.1}Ga_{0.9}N$ is grown up by 25-A thickness, then TMA was stopped and GaN which $cm^{-3}$[ $1x10^{20}$/]-doped Mg was grown up by 25-A thickness, using $Cp_2Mg$ as impurity gas. This operation was repeated by turns and the p type clad layer 42 which consists of a superstructure of 0.6 micrometer of the total thickness was grown up.
[0046]Next, TMG and ammonia were used for material gas at the temperature of 1050 **, and the p type contact layer 43 which consists of GaN which $cm^{-3}$[ $1x10^{20}$/]-doped Mg was grown up by 25-A thickness, using $Cp_2Mg$ as impurity gas.

[0047]After ending reaction and in the reaction vessel, annealing was performed for the wafer at 700 ** among a nitrogen atmosphere, and the p type layer was low-resistance-ized further.
[0048]The wafer into which the nitride semiconductor was grown up as mentioned above is picked out from a reaction vessel. In order to expose the n type contact layer 35, the $SiO_2$ mask was formed in a part of p type contact layer 43, and it etched in RIE (reactive ion etching), and the surface of the n type contact layer 35 was exposed.
[0049]The surface of the p type contact layer 43 of the top layer and the $SiO_2$ mask which were exposed and which becomes a p type nitride semiconductor layer from a 1.5-micrometer-wide stripe via the mask of predetermined shape all over the n type contact layer 35 were formed. After $SiO_2$ mask formation, using RIE, it etched to near the interface of the p type clad layer 42 and the p type guide layer 41, and the waveguide (ridge) of 1.5-micrometer-wide stripe shape was formed.
[0050]The 1st insulator layer 60 that consists of $ZrO_2$ on the surface of a p type nitride semiconductor layer was formed after ridge formation, with the $SiO_2$ mask attached. This 1st insulator layer 60 may carry out the mask of the n lateral electrode 51 forming face first, and may form the 1st insulator layer 60 all over a nitride semiconductor layer. It is immersed in buffered fluoric acid after the 1st insulator layer formation, carry out dissolution removal of the $SiO_2$ mask formed on the p type contact layer 43, and by the lift-off method with $SiO_2$, $ZrO_2$ in the p type contact layer 43 (further on the n type contact layer 35) was removed. This $ZrO_2$ can also be formed at one process as the low reflective film of the optical outgoing radiation side-mirrors side of this invention, and a protective film of a light reflex side-mirrors side.
[0051]Next, the ridge outermost surface on the p type contact layer 43 and the p lateral electrode 50 which consists of nickel/Au in contact with the 1st insulator layer 60 were formed in stripe shape. On the other hand, the n lateral electrode 51 which becomes the surface (reaching and touching the 1st insulator layer 60) on the n type contact layer 35 from Ti/aluminum was formed in stripe shape. After forming these, oxygen:nitrogen carried out annealing of each at 600 ** with a rate of 80:20, the p lateral electrode 50 and the n lateral electrode 51 were alloyed, and the good ohmic characteristic was obtained.
[0052]Next, the 2nd insulator layer 61 that consists of $SiO_2$ was formed in the whole surface, and some of p lateral electrodes 50 and n lateral electrodes 51 were exposed by applying and carrying out dry etching of the resist to the whole surface except some of p lateral electrodes 50 and n lateral electrodes. This $SiO_2$ can also be formed at one process as some of low reflective films of the optical outgoing radiation side-mirrors side of this invention, and high reflection films of a light reflex side-mirrors side.
[0053]The n side formed the adhesion layer which consists of nickel at one process so that the 2nd part and n lateral electrode 51 of the insulator layer 61 may be covered by 1000-A thickness so that the p side might cover the 2nd insulator layer 61 and p lateral electrode 50 on a p type nitride semiconductor layer as the pad electrode 70 after the 2nd insulator layer 61 formation. On the adhesion layer, the barrier layer which consists of Ti was continued by 1000-A thickness, and Au was formed by 8000-A thickness.
[0054]After grinding the silicon on sapphire of the wafer in which p lateral electrode and n lateral electrode were formed and being referred to as 70 micrometers, in the direction vertical to the electrode of stripe shape, cleavage was carried out to bar shape from the substrate side, and the resonator was produced to the cleavage plane (the 11 to 00th page, the field =M side equivalent to the side of a hexagonal prism-like crystal). This resonator could be formed by etching.
[0055]Next, the sputter device was used for the optical outgoing radiation side-mirrors side of the resonator, and the 1st low reflective film that consists of $ZrO_2$, and the 2nd low reflective film that consists of $SiO_2$ were formed in it. Here, the thickness of the 1st low reflective film and the 2nd low reflective film is 470 A and 690A, respectively. On the other hand, using the sputter device, the protective film which consists of $ZrO_2$ was formed, it ranked second to a light reflex side-mirrors side, $SiO_2$ and three pairs of $ZrO_2$ were laminated to it by turns, and the high reflection film was formed in it. Here, the thickness of a protective film, the $SiO_2$ film which constitutes a high reflection film, and a $ZrO_2$ film is 470 A, 690 A, and 470A, respectively. And finally, in the direction parallel to p lateral electrode, the bar was cut and it was considered as the laser device.
[0056]The obtained laser device was installed in the heat sink, wire bonding of each electrode was carried out, and laser oscillation was tried at the room temperature. As a result, in the room temperature, on threshold 2.2 $kA/cm^2$ and the threshold voltage 4.2V, continuous oscillation with an oscillation wavelength of 400 nm was checked, and the life improved by 1.8 times compared with the conventional element of a comparative example.

Although the threshold became high a little compared with the former, as for the slope efficiency which shows inclination of current-output characteristics, 30% of improvement was found compared with the former. These results to this light emitting device is useful to a high-output laser device.
[0057]Example 2 is described using example 2. drawing 2. In Example 1, from the silicon on sapphire in which the foundation layer was formed, silicon on sapphire and a buffer layer were ground and removed, it was considered only as the undoped GaN layer, and this was made into the substrate 11. However, the thickness at the time of growing up undoped GaN layer 34 could be 80 micrometers.
[0058]Next, at the temperature of 1050 **, TMG and ammonia were used for the raw material at gas, silane gas was used for impurity gas, and the n type contact layer 12 which consists of GaN which $cm^{-3}$[ 3x10 $^{18}$/]-doped Si was grown up by 3-micrometer thickness.
[0059]Next, temperature shall be 800 ** and TMG, TMI (trimethylindium), and ammonia are used for material gas, Silane gas was used for impurity gas and the crack prevention layer 13 which consists of $In_{0.14}Ga_{0.86}N$ which $cm^{-3}$[ 5x10 $^{18}$/]-doped Si was grown up by 0.1 micrometer of thickness.
[0060]Shall make the inside of a reaction vessel into a hydrogen atmosphere, and temperature shall be 1050 **, and to material gas Next, TMA, Using TMG and ammonia, undoped $aluminum_{0.14}Ga_{0.86}N$ was grown up by 25-A thickness, then TMA was stopped, and GaN which $cm^{-3}$[ 1x10 $^{19}$/]-doped Si was grown up by 25-A thickness, using silane gas as impurity gas. This operation was repeated 240 times by turns, and the n type clad layer 14 which consists of a superstructure of 1.2 micrometers of the total thickness was grown up.
[0061]Next, TMG and ammonia were used for material gas at the temperature of 1050 **, and the n type guide layer 15 which consists of undoped GaN was grown up by 0.1 micrometer of thickness.
[0062]Next, temperature was 800 **, TMG, TMI, and ammonia were used for material gas, silane gas was used for impurity gas, and the barrier layer which consists of $In_{0.02}Ga_{0.98}N$ which $cm^{-3}$[ 5x10 $^{18}$/]-doped Si was grown up by 50-A thickness. Then, the well layer which consists of $In_{0.15}Ga_{0.85}N$ of a Si dope was grown up by 20-A thickness. This operation was repeated 4 times and the active layer 16 of the multiple quantum well structure of 330 A of the total thickness that finally laminated the barrier layer was grown up.
[0063]Next, TMA, TMG, and ammonia are used for material gas at the temperature of 800 **, The p type capping layer 17 which consists of $aluminum_{0.2}Ga_{0.8}N$ which $cm^{-3}$[ 1x10 $^{20}$/]-doped Mg was grown up by 200-A thickness, using $Cp_2Mg$ (magnesium cyclopentadienyl) as impurity gas.
[0064]Next, temperature was 1050 **, TMG and ammonia were used for material gas, and the p type guide layer 18 which consists of undoped GaN was grown up by 0.1 micrometer of thickness. Although this p type guide layer was grown up as undoped, by diffusion of Mg from the p type capping layer 17, Mg concentration serves as 1x10 $^{18}/cm^3$, and it shows a p type.
[0065]Next, TMA, TMG, and ammonia are used for material gas at the temperature of 1050 **, Undoped $aluminum_{0.14}Ga_{0.86}N$ is grown up by 25-A thickness, then TMA was stopped and GaN which $cm^{--3}$[ 1x10 $^{20}$/]-doped Mg was grown up by 25-A thickness, using $Cp_2Mg$ as impurity gas. This operation was repeated by turns and the p type clad layer 19 which consists of a superstructure of 0.6 micrometer of the total thickness was grown up.
[0066]Next, TMG and ammonia were used for material gas at the temperature of 1050 **, and the p type contact layer 20 which consists of GaN which $cm^{-3}$[ 1x10 $^{20}$/]-doped Mg was grown up by 0.05 micrometer of thickness, using $Cp_2Mg$ as impurity gas.
[0067]After ending reaction and in the reaction vessel, annealing was performed for the wafer at 700 ** among a nitrogen atmosphere, and the p type layer was low-resistance-ized further.
[0068]The wafer into which the nitride semiconductor was grown up as mentioned above was picked out from the reaction vessel, in order to expose the n type contact layer 12, the $SiO_2$ mask was formed in a part of p type contact layer 20, and it etched in RIE, and the surface of the n type contact layer 12 was exposed.
[0069]The surface of the p type contact layer 20 of the top layer and the $SiO_2$ mask which were exposed and which becomes a p type nitride semiconductor layer from a 1.5-micrometer-wide stripe via the mask of predetermined shape all over the n type contact layer 12 were formed. After $SiO_2$ mask formation, using RIE, it etched to near the interface of the p type clad layer 19 and the p type guide layer 18, and the waveguide (ridge) of 1.5-micrometer-wide stripe shape was formed.
[0070]Next, the p lateral electrode 23 which becomes the ridge outermost surface on the p type contact layer

20 from nickel/Au was formed in stripe shape. On the other hand, the n lateral electrode 22 which becomes the surface on the n type contact layer 35 from Ti/aluminum was formed in stripe shape. After forming these, oxygen:nitrogen carried out annealing of each at 600 ** with a rate of 80:20, the p lateral electrode 23 and the n lateral electrode 22 were alloyed, and the good ohmic characteristic was obtained.
[0071]Next, the insulator layer 21 which consists of $SiO_2$ was formed in the whole surface, and some p lateral electrodes 23 and the n lateral electrode 22 were exposed by applying and carrying out dry etching of the resist to some p lateral electrodes 23 and the whole surface except the n lateral electrode 22. This $SiO_2$ can also be formed at one process as some of low reflective films of the optical outgoing radiation side-mirrors side of this invention, and high reflection films of a light reflex side-mirrors side. [0072]After grinding the silicon on sapphire of the wafer in which p lateral electrode and n lateral electrode were formed and being referred to as 70 micrometers, in the direction vertical to the electrode of stripe shape, cleavage was carried out to bar shape from the substrate side, and the resonator was produced to the cleavage plane (the 11 to 00th page, the field =M side equivalent to the side of a hexagonal prism-like crystal). This resonator could be formed by etching.
[0073]Next, the sputter device was used for the optical outgoing radiation side-mirrors side of the resonator, and the 1st low reflective film that consists of $ZrO_2$, and the 2nd low reflective film that consists of $SiO_2$ were formed in it. Here, the thickness of the 1st low reflective film and the 2nd low reflective film is 470 A and 690A, respectively. On the other hand, using the sputter device, the protective film which consists of $ZrO_2$ was formed, it ranked second to a light reflex side-mirrors side, $SiO_2$ and three pairs of $ZrO_2$ were laminated to it by turns, and the high reflection film was formed in it. Here, the thickness of a protective film, the $SiO_2$ film which constitutes a high reflection film, and a $ZrO_2$ film is 470 A, 690 A, and 470A, respectively. And finally, in the direction parallel to p lateral electrode, the bar was cut and it was considered as the laser device.
[0074]The obtained laser device was installed in the heat sink, wire bonding of each electrode was carried out, and laser oscillation was tried at the room temperature. As a result, in the room temperature, on threshold 2.2 $kA/cm^2$ and the threshold voltage 4.2V, continuous oscillation with an oscillation wavelength of 400 nm was checked, and the life improved by 2.0 times compared with the conventional element of a comparative example. Although the threshold became high a little compared with the former, as for slope efficiency, 30% of improvement was found compared with the former. These results to this light emitting device is useful to a high-output laser device.
[0075]As shown in example 3. drawing 1, C side was set in the MOCVD system using the silicon on sapphire which makes the principal surface and a cage hula side A side as a substrate, thermal cleaning for 10 minutes was performed at the temperature of 1050 **, and the affix of moisture or the surface was removed. Next, temperature of 510 ** was used, hydrogen was used for carrier gas, ammonia and trimethylgallium were used for material gas, and the buffer layer which consists of GaN(s) was grown up by 200-A thickness. Then, the GaN layer which consists of undoping was formed by 20 micrometers of thickness at 1050 **.
[0076]Next, it sets in a hydride vapor-phase-epitaxial-growth (HVPE) device. Ga metal is prepared for a quartz boat, by using HCl gas for halogen gas, generated $GaCl_3$, next it was made to react to the ammonia gas as an N gas source, and the 2nd GaN layer that consists of undoped GaN was grown up by 200-micrometer thickness.
[0077]Next, it is made to be the same as that of Example 1 until it forms the p type contact layer 43 of the top layer from the n type nitride semiconductor layer 35 which consists of Si dopes.
[0078]After forming and low-resistance-izing even the p type contact layer 43, the surface of a n type contact layer is exposed, and it etches so that the resonator face by the side of optical outgoing radiation and a light reflex may be formed simultaneously.
[0079]Furthermore, the surface of the p type contact layer 43 of the top layer and the $SiO_2$ mask which were exposed and which becomes a p type nitride semiconductor layer from a 1.5-micrometer-wide stripe via the mask of predetermined shape all over the n type contact layer 35 were formed. After $SiO_2$ mask formation, using RIE, it etched to near the interface of the p type clad layer 42 and the p type guide layer 41, and the waveguide (ridge) of 1.5-micrometer-wide stripe shape was formed.
[0080]A $SiO_2$ mask is further formed also in a light emitting surface after ridge formation, with a $SiO_2$ mask attached. The 1st insulator layer 60 that furthermore consists of $ZrO_2$ on the surface of a p type nitride semiconductor layer was formed. This 1st insulator layer 60 may carry out the mask of the n lateral electrode 51 forming face first, and may form the 1st insulator layer 60 all over a nitride semiconductor layer. It is immersed in buffered fluoric acid after the 1st insulator layer formation, carry out dissolution removal of the $SiO_2$ mask

formed on the p type contact layer 43, and by the lift-off method with $SiO_2$, $ZrO_2$ in the p type contact layer 43 (further on the n type contact layer 35) was removed. This $ZrO_2$ is formed also as a protective film of a light reflex side-mirrors side.
[0081]Next, the p lateral electrode 50 which consists of nickel/Au in contact with the ridge outermost surface and the 1st insulator layer 60 on the p type contact layer 43 was formed in stripe shape.
[0082]The n lateral electrode 51 which becomes the surface (and surface of the 1st insulator layer 60) on the n type contact layer 35 from Ti/aluminum on the other hand was formed in stripe shape.
[0083]After forming these, at a rate of 80:20, oxygen:nitrogen carried out annealing at 600 **, alloyed the p lateral electrode 50 and the n lateral electrode 51, and obtained the good ohmic characteristic, respectively.
[0084]Next, resist is applied to the ridge outermost surface and a light emitting end side, and each thickness forms three pairs of multilayer films of $SiO_2$ and $ZrO_2$ at 690 A and 470 A as the 2nd insulator layer 61. At this time, the multilayer film of $SiO_2$ and $ZrO_2$ is formed following $ZrO_2$ in which the light reflection surface was formed beforehand.
[0085]Then, so that resist may be removed and the p side may cover the 2nd insulator layer 61 and p lateral electrode 50 on a p type nitride semiconductor layer as the pad electrode 70, The n side formed the barrier layer which consists of 100 A and Ti the adhesion layer which comprises nickel at one process at 1000 A so that the 2nd part and n lateral electrode 51 of the insulator layer 61 might be covered, and it formed Au by 8000-A thickness.
[0086]Next, it etches in a position which does not interrupt emitted light so that the laser beam emitted from the optical outgoing radiation side may serve as a good far field pattern so that it may be easy to carry out chip making of the element. As this method, resist is first applied to a non-etching part as a mask (the 1st resist). Furthermore, $SiO_2$ and also the 2nd resist are continuously formed on the 1st resist. It etches by RIE until it etches $SiO_2$ and sapphire exposes GaN of an etching part continuously by RIE further. It is formed by finally removing the 1st resist (from the 1st resist to a lift off).
[0087]Next, resist was applied all over removing the laser emission face by the side of an emission face, the 1st low reflective film that consists of $ZrO_2$, and the 2nd low reflective film that consists of $SiO_2$ were formed by thickness (470 A and 690 A) using the sputter device, respectively, and resist was removed.
[0088]And finally, over the sapphire exposed surface, scribing etc. cut from the rear face and it was considered as the laser device. The characteristic of the obtained laser device was almost equivalent to Example 1.
[0089]As shown in example 4 drawing 1, C side was set in the MOCVD system using the silicon on sapphire which makes the principal surface and a cage hula side A side as a substrate, thermal cleaning for 10 minutes was performed at the temperature of 1050 **, and the affix of moisture or the surface was removed.
[0090]Next, temperature of 510 ** was used, hydrogen was used for carrier gas, ammonia and trimethylgallium were used for material gas, and the buffer layer which consists of GaN(s) was grown up by 200-A thickness. Then, the GaN layer which consists of undoping was formed by 20 micrometers of thickness at 1050 **.
[0091]Next, it sets in a hydride vapor-phase-epitaxial-growth (HVPE) device, Prepare Ga metal for a quartz boat and $GaCl_3$ is generated by using HCl gas for halogen gas, Next, it was made to react to the ammonia gas as an N gas source, and the 2nd GaN layer that consists of Si dope GaN was further grown up by 200-micrometer thickness, using dichlorosilane ($SiH_2Cl_2$) gas as impurity doping gas.
[0092]Next, the simple substance board which removes sapphire on the back by polish, and consists the obtained wafer of Si dope GaN was obtained. Next, it is made to be the same as that of Example 1 until it forms the p type contact layer 43 of the top layer from the n type nitride semiconductor layer 35 which consists of Si dopes. After forming and low-resistance-izing even the p type contact layer 43, the surface of the n type contact layer was exposed to stripe shape.
[0093]Furthermore, the surface of the p type contact layer 43 of the top layer and the $SiO_2$ mask which were exposed and which becomes a p type nitride semiconductor layer from a 1.5-micrometer-wide stripe via the mask of predetermined shape all over the n type contact layer 35 were formed. After $SiO_2$ mask formation, using RIE, it etched to near the interface of the p type clad layer 42 and the p type guide layer 41, and the waveguide (ridge) of 1.5-micrometer-wide stripe shape was formed.
[0094]The 1st insulator layer 60 that consists of $ZrO_2$ was formed in the surface of a p type nitride semiconductor layer after ridge formation. This 1st insulator layer 60 may carry out the mask of the n lateral electrode 51 forming face first, and may form the 1st insulator layer 60 all over a nitride semiconductor layer. It is immersed in buffered fluoric acid after the 1st insulator layer formation, carry out dissolution removal of the

$SiO_2$ mask formed on the p type contact layer 43, and by the lift-off method with $SiO_2$, $ZrO_2$ in the p type contact layer 43 (further on the n type contact layer 35) was removed. This $ZrO_2$ is formed also as a protective film of a light reflex side-mirrors side.
[0095]Next, the p lateral electrode 50 which consists of nickel/Au in contact with the ridge outermost surface and the 1st insulator layer 60 on the p type contact layer 43 was formed in stripe shape.
[0096]The n lateral electrode 51 which becomes the surface (and surface of the 1st insulator layer 60) on the n type contact layer 35 from Ti/aluminum on the other hand was formed in stripe shape.
[0097]After forming these, at a rate of 80:20, oxygen:nitrogen carried out annealing at 600 **, alloyed the p lateral electrode 50 and the n lateral electrode 51, and obtained the good ohmic characteristic, respectively. Next, resist was applied to the ridge outermost surface and $SiO_2$ was formed as the 2nd insulator layer 61.
[0098]Then, so that resist may be removed and the p side may cover the 2nd insulator layer 61 and p lateral electrode 50 on a p type nitride semiconductor layer as the pad electrode 70, The n side formed the barrier layer which consists of 100 A and Ti the adhesion layer which comprises nickel at one process at 1000 A so that the 2nd part and n lateral electrode 51 of the insulator layer 61 might be covered, and it formed Au by 8000-A thickness.
[0099]Next, cleavage of the wafer was carried out in the direction parallel to the electrodes of stripe shape from the Si-dope GaN board side, and the resonator was produced to the cleavage plane cleavage plane (the 11 to 00th page, the field =M side equivalent to the side of a hexagonal prism-like crystal).
[0100]Next, the sputter device was used for the optical outgoing radiation side-mirrors side of the resonator, and the 1st low reflective film that consists of $ZrO_2$, and the 2nd low reflective film that consists of $SiO_2$ were formed in it. At this time, an optical outgoing radiation side-mirrors side is installed so that the target of a sputter device may be countered. Here, the thickness of the 1st low reflective film and the 2nd low reflective film is 470 A and 690A, respectively.
[0101]The optical outgoing radiation side-mirrors side was turned down, the optical outgoing radiation side-mirrors side was installed so that the target of a sputter device might be countered, on the other hand, the protective film which consists of $ZrO_2$ was formed in the light reflex side-mirrors side, it ranked second, $SiO_2$ and three pairs of $ZrO_2$ were laminated by turns, and the high reflection film was formed. Here, the thickness of a protective film, the $SiO_2$ film which constitutes a high reflection film, and a $ZrO_2$ film is 470 A, 690 A, and 470A, respectively. And finally, in the direction parallel to p lateral electrode, the bar was cut and it was considered as the laser device.
[0102]The obtained laser device was installed in the heat sink, wire bonding of each electrode was carried out, and laser oscillation was tried at the room temperature. As a result, in the room temperature, on threshold 2.2 $kA/cm^2$ and the threshold voltage 4.2V, continuous oscillation with an oscillation wavelength of 400 nm was checked, and the life improved by 1.8 times compared with the conventional element of a comparative example. Although the threshold became high a little compared with the former, as for the slope efficiency which shows inclination of current-output characteristics, 30% of improvement was found compared with the former. These results to this light emitting device is useful to a high-output laser device.
[0103]As shown in example 5 drawing 1, C side was set in the MOCVD system using the silicon on sapphire which makes the principal surface and a cage hula side A side as a substrate, thermal cleaning for 10 minutes was performed at the temperature of 1050 **, and the affix of moisture or the surface was removed.
[0104]Next, temperature of 510 ** was used, hydrogen was used for carrier gas, ammonia and trimethylgallium were used for material gas, and the buffer layer which consists of GaN(s) was grown up by 200-A thickness. Then, the GaN layer which consists of undoping was formed by 20 micrometers of thickness at 1050 **.
[0105]Next, it sets in a hydride vapor-phase-epitaxial-growth (HVPE) device, Ga metal is prepared for a quartz boat, by using HCl gas for halogen gas, generated $GaCl_3$, next it was made to react to the ammonia gas as an N gas source, and the GaN layer which consists of undoping of a thick film further was grown up by 200-micrometer thickness.
[0106]Next, it was made to be the same as that of Example 1 until it formed the p type contact layer 43 of the top layer from the n type nitride semiconductor layer 35 which consists of Si dopes.
[0107]After forming and low-resistance-izing even the p type contact layer 43, the surface of the n type contact layer was exposed to stripe shape by etching. By this etching, the end face of the resonator was also formed simultaneously.
[0108]Furthermore, the surface of the p type contact layer 43 of the top layer and the $SiO_2$ mask which were exposed and which becomes a p type nitride semiconductor layer from a 1.5-micrometer-wide stripe via the

mask of predetermined shape all over the n type contact layer 35 were formed. After $SiO_2$ mask formation, using RIE, it etched to near the interface of the p type clad layer 42 and the p type guide layer 41, and the waveguide (ridge) of 1.5-micrometer-wide stripe shape was formed.

[0109]the surface of after ridge formation and a p type nitride semiconductor layer -- further, three pairs were laminated [ 690 A and $ZrO_2$ ] for the combination of 470 A in order, and 470 A of $ZrO_2$ was used as the 1st insulator layer 60 for $SiO_2$. This 1st insulator layer 60 may carry out the mask of the optical outgoing radiation side-mirrors side first, may form the 1st insulator layer 60 all over a nitride semiconductor layer, and immerses in buffered fluoric acid after the 1st insulator layer formation in that case. Dissolution removal of the $SiO_2$ mask formed on the p type contact layer 43 was carried out, and the p type contact layer 43, a light emitting surface side-mirrors side, and $ZrO_2$ that is on the n type contact layer 35 further were removed with $SiO_2$ by the lift-off method.

[0110]Next, the 1st resist was patterned according to the chip size of an element, the mask which consists of $SiO_2$ was further formed in the entire wafer surface, and the 2nd resist was further patterned in the same shape as the 1st resist on it. As for the 1st resist, at this time, the outgoing radiation mirror plane side is patterned after the outside and just before a little from the outgoing radiation mirror plane. And $SiO_2$ is first etched by RIE, and it etches until the sapphire of a substrate exposes the nitride semiconductor layer exposed surface which removes $SiO_2$ of a $SiO_2$ exposed surface and to which the 1st resist then is not applied by RIE. A good far field pattern can be formed without emitted light shining upon a nitride semiconductor layer, when a laser beam is oscillated since the outside and a last-minute nitride semiconductor layer are removed from the outgoing radiation mirror plane by etching for a while by this etching as for the outgoing radiation mirror plane side. By finally removing from the 1st resist, the mask of $SiO_2$ and the 2nd resist is also removable at once.

[0111]Next, in the light emitting surface side-mirrors side, it patterned by resist so that only a ridge part and a light emitting part might be exposed at least, and on it, the sputter device was also used and $ZrO_2$ and $SiO_2$ were formed by thickness (470 A and 690 A) to the optical emission direction, respectively. By finally removing a resist film, three pairs were formed [ $ZrO_2$ and $SiO_2$ ] in the light emitting end side for the multilayer of $ZrO_2$, and $SiO_2$ and $ZrO_2$ in the light reflex end face.

[0112]Finally according to the chip size, it patterned, cut in the part to which even sapphire was exposed, and was considered as the laser device. The characteristic of the obtained laser device was almost equivalent to Example 1.

[0113]Except not having formed a low reflective film in the example 6. light outgoing radiation side-mirrors side, by the same method as Example 2, the laser device was produced and laser oscillation was tried at the room temperature. As a result, in the room temperature, on threshold 2.2 $kA/cm^2$ and the threshold voltage 4.2V, continuous oscillation with an oscillation wavelength of 400 nm was checked, and the life improved by 2.0 times compared with the conventional element of a comparative example. These results to this light emitting device is useful to a high-output laser device.

[0114]Except not having formed in the comparative example . light outgoing radiation side-mirrors side at a low reflective film, and not having formed a protective film in the light reflex side-mirrors side, the laser device was produced by the same method as Example 2, and laser oscillation was tried at the room temperature. As a result, in the room temperature, continuous oscillation with an oscillation wavelength of 400 nm was checked on threshold 2.0 $kA/cm^2$ and the threshold voltage 4.0V, and the estimated life expectancy showed 1000 hours or more at the room temperature.

[0115]

[Effect of the Invention]As stated above, the gallium nitride system light emitting device of this invention. The low reflective film more than two-layer [ which has a refractive index lower than gallium nitride in an optical outgoing radiation side-mirrors side ], From an optical outgoing radiation side-mirrors side, laminate so that a refractive index may become low in order, and the 1st low reflective film right above an optical outgoing radiation side-mirrors side, Since it formed with a gap or one sort of materials to be chosen from $ZrO_2$, MgO, aluminum$_2O_3$, $Si_3N_4$, AlN, and $MgF_2$, slope efficiency and a life can be raised and a highly reliable light emitting device can be provided by high power.

[0116]The gallium nitride system light emitting device of this invention forms the 1st low reflective film with a gap or one sort of materials to be chosen from $ZrO_2$, $Si_3N_4$, and AlN, Since a gap to be chosen from $SiO_2$,

aluminum$_2$O$_3$, MgO, and MgF$_2$ or the 2nd low reflective film that consists of one sort was formed on the 1st low reflective film, the reliability of a light emitting device can be improved more.
[0117]Since the gallium nitride system light emitting device of this invention formed in the optical outgoing radiation side-mirrors side the gap to be chosen from MgO, aluminum$_2$O$_3$, and MgF$_2$, or the low reflective film of one layer which consists of one sort, a laser device with high slope efficiency is obtained.
[0118]The gallium nitride system light emitting device of this invention forms in a light reflex side-mirrors side a gap to be chosen from $ZrO_2$, MgO, $Si_3N_4$, AlN, and $MgF_2$, or the protective film which consists of one sort, And since the high reflection film which laminates a low refractive index layer and a high refractive index layer by turns was formed on the protective film, end face destruction can be controlled and the life at the time of a high-output operation can be raised.
[0119]The gallium nitride system light emitting device of this invention in an optical outgoing radiation side-mirrors side. From an optical outgoing radiation side-mirrors side, the low reflective film more than two-layer [ which has a refractive index lower than gallium nitride ] is laminated so that a refractive index may become low in order, The 1st low reflective film right above an optical outgoing radiation side-mirrors side comprises a gap to be chosen from $ZrO_2$, MgO, aluminum$_2$O$_3$, $Si_3N_4$, AlN, and $MgF_2$, or one sort, A gap to be chosen from $ZrO_2$, MgO, $Si_3N_4$, AlN, and $MgF_2$ or the protective film which consists of one sort is formed in a light reflex side-mirrors side, And since the high reflection film which laminates a low refractive index layer and a high refractive index layer by turns is formed on a protective film and it was made to become, the slope efficiency and the life at the time of a high-output operation can be raised especially.
[0120]Since the gallium nitride system light emitting device of this invention formed the low refractive index layer and high refractive index layer of the high reflecting layer by $SiO_2$ and $ZrO_2$, respectively, it can raise the reflectance of a high reflecting layer and can raise an output more.

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[Translation done.]



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## DESCRIPTION OF DRAWINGS

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[Brief Description of the Drawings]
[Drawing 1]It is a pattern perspective view showing the structure of the gallium nitride system light emitting device concerning the embodiment of the invention 1.
[Drawing 2]It is a type section figure showing the structure of the gallium nitride system light emitting device concerning the embodiment of the invention 1.
[Drawing 3]It is a perspective view showing the structure of the gallium nitride system light emitting device concerning the embodiment of the invention 2.
[Drawing 4]It is a type section figure showing the structure of the gallium nitride system light emitting device concerning the embodiment of the invention 2.
[Drawing 5]It is a perspective view showing the structure of the conventional gallium nitride system light emitting device.
[Description of Notations]
1, 2 gallium-nitride system light emitting device, 11 GaN board, 12, 35 n type contact layers, 13 and 36 A crack prevention layer, 14, 37 n type clad layers, 15, 38 n type guide layers, 16, 39 active layers, 17, 40 p type capping layers, 18, 41 p-type guide layer, 19, 42 p type clad layers, 20, 43 p type contact layers, and 21 Insulator layer, 22, 51 n lateral electrode, 23, 50 p lateral electrode, 31 silicon on sapphire, 32 A buffer layer, and 33 and 34 A undoped GaN layer and 60 The 1st insulator layer and 61 The 2nd insulator layer, 70 pad electrodes, and 80 [ A

multilayer low reflective film and 81 ] [ The 1st reflection film and 82 ] [ The 2nd reflection film and 90 ] [ A protective film and 91 ] [ A high reflection film and 92 ] [ Cascade screen of a low refractive index layer and a high refractive index layer. ]

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[Translation done.]

* NOTICES *

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1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

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DRAWINGS

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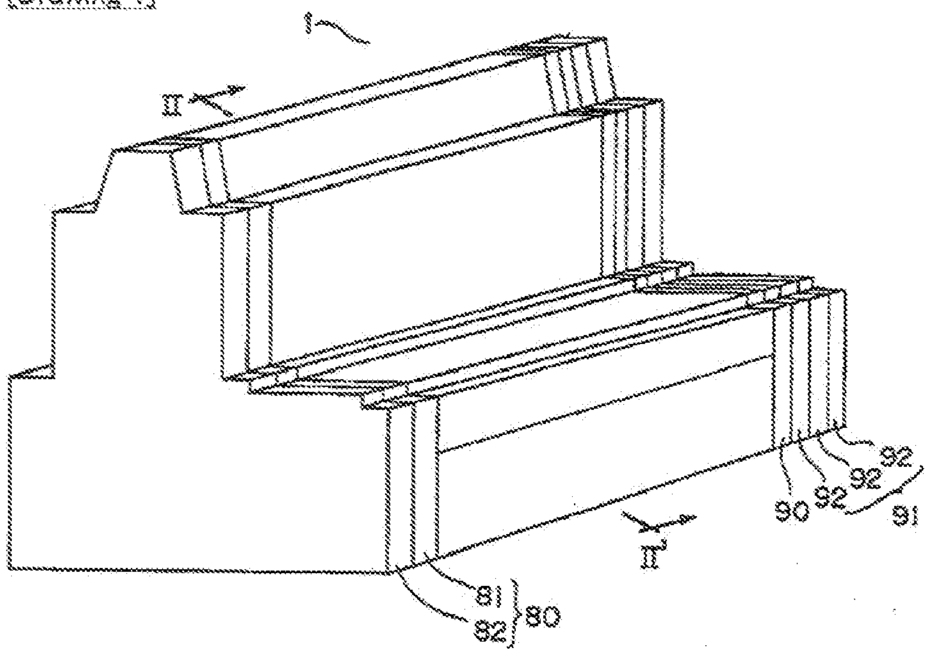
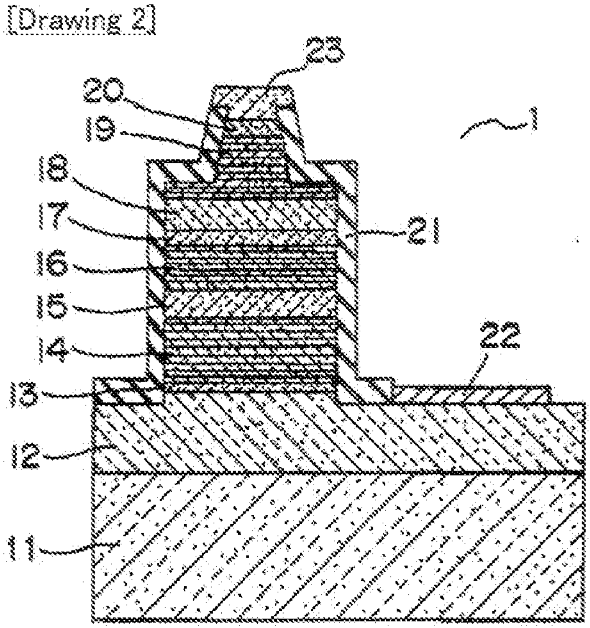
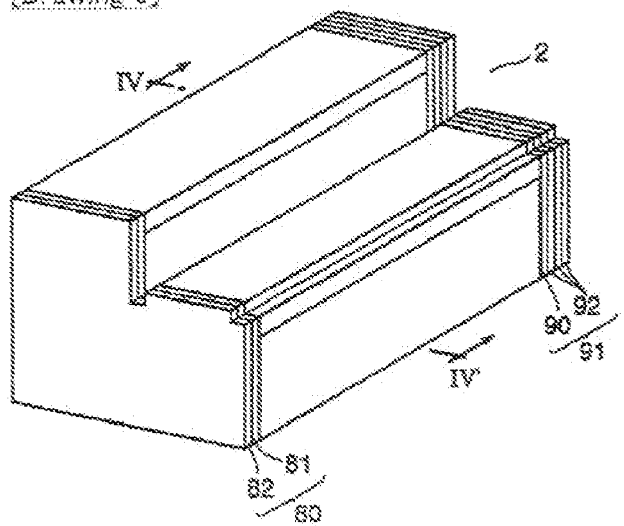
[Drawing 1]



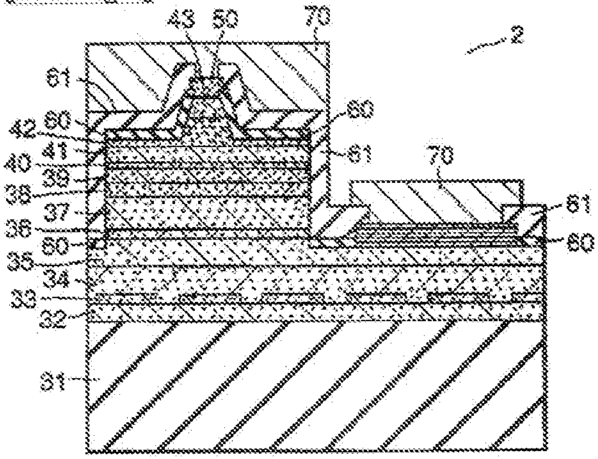

[Drawing 2]



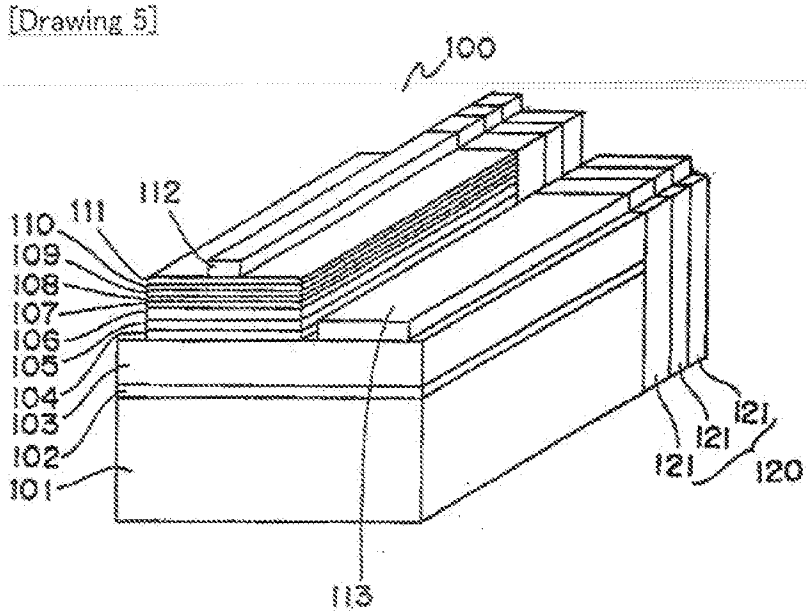
[Drawing 3]




[Drawing 4]




[Drawing 5]




[Translation done.]